COMPREHENSIVE ENVIRONMENTAL ASSESSMENT AND RESPONSE PROGRAM (CEARP)
REMEDIAL INVESTIGATIONS
FOR
HIGH PRIORITY SITES:
DRILLING, SAMPLING, TESTING
AND WELL CONSTRUCTION SPECIFICATIONS

ROCKY FLATS PLANT
GOLDEN, COLORADO

PREPARED BY
ENVIRONMENTAL MANAGEMENT
ROCKWELL INTERNATIONAL
NORTH AMERICAN SPACE OPERATIONS

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COMPREHENSIVE ENVIRONMENTAL ASSESSMENT AND RESPONSE PROGRAM
PHASE II: DRILLING, SAMPLING, TESTING AND WELL CONSTRUCTION SPECIFICATIONS
(HIGH PRIORITY SITES)

SCOPE

This task is part of a comprehensive program of remedial investigations, feasibility studies and remedial/corrective action projects to be performed at Rocky Flats. This phase (Phase II) will focus on characterization of contamination sources and delineation of contaminated groundwater plumes.

The scope of work for this task encompasses Phase II activities for high priority sites only and includes drilling, soil and waste sampling, packer testing and monitoring well construction. All work will be planned and performed as part of an integrated team directed by Rockwell's project manager. This project team will be composed of personnel from Rockwell International, consulting firms and contractors. Close cooperation between team members working on related tasks is essential to the achievement of program goals.

DESCRIPTION OF WORK

The work consists of drilling and sampling test borings; and drilling, sampling, completing, and developing monitor wells at the Rocky Flats Plant. The wells shall be completed in surficial materials (slope wash, valley fill materials, Rocky Flats Alluvium) and in the first saturated sandstone bedrock of the Arapahoe or Laramie formations. Bedrock wells shall be packer tested prior to completion.

The work site is located approximately 16 miles northwest of downtown Denver, Colorado. The site is owned by the United States Department of Energy and operated by Rockwell International. Drilling will be performed by the Contractor and will be supervised by Rockwell International or its designated representatives.

The work must be performed in manner that meets all regulations with careful attention to the details of geology and well construction. In addition, every effort must be made to avoid the introduction of contaminants into the wells during drilling, construction, and development.

The Contractor will be responsible for providing all equipment, labor, materials, and other miscellaneous items needed to complete the work.

CONDUCT OF WORK

Access

Access to drilling sites will be provided by Rockwell International. The Contractor will be responsible for moving equipment between drill sites and on and off the property. All pads and other necessary site preparation, if any, will also be the Contractor's responsibility.

Surveys

Rockwell International will designate the borehole and well locations by means of stakes or other identifying marks. The Contractor shall not proceed with any work until the field locations have been established and verified by Rockwell International.

Clean Work Area

The Contractor shall not allow the work sites to become littered with trash and waste material, but rather, shall maintain the sites in a neat and orderly condition throughout the work period. Upon completion of work, the Contractor shall remove all temporary structures erected by him and all debris and surplus materials of every description. The drill sites shall be left in a condition acceptable to Rockwell International before final payment is made.

Period of Performance

The work shall be performed in the most expeditious manner possible using three drilling rigs. The period of performance is from April 1987 to September 1987. Once begun, work shall continue without interruption to its conclusion unless authorized by Rockwell International. In no event will final payment be made for the work until all work is complete.

SAMPLING EQUIPMENT AND PROCEDURES

Equipment and procedures to be used are presented in Appendix A. Appendix A includes procedures for drilling and sampling, equipment decontamination, packer testing, and well installation and development.

SOIL SAMPLES COLLECTED DURING DRILLING

Samples will be collected from borings at and near waste sources. Continuous drive samples will be collected from the ground surface to total depth where possible. Total depth will vary depending on visual description of samples (i.e., presence of stains for metals) and screening for organics and radionuclides. Screening will also be used to determine which samples to submit for laboratory analysis.

Approximately 112 borings will be performed to characterize the nature and volume of soils and wastes. The rig geologist will develop borehole logs based on continuous samples, core, cuttings, and rig behavior as the drilling progresses. The Contractor shall aid the geologist in this task as necessary, including sample collection (if requested) and the maintenance of a reasonable penetration rate. General drilling and sampling procedures are described in Appendix A.

Boreholes not completed as wells will be backfilled by tremie grouting with neat cement (Portland Type I) grout. The cement grout can be poured from the surface if total borehole depth is less than five feet.

Sampling equipment will be decontaminated prior to each use in accordance with the standard protocol presented in Appendix A.

MONITORING WELL INSTALLATION

Approximately 25 alluvial and 20 bedrock monitoring wells will be installed to characterize groundwater quality. The wells will be drilled to depths designated by Rockwell International or its designated representatives. The holes shall not deviate from plume by more than 2.5%. Well screen and filter pack sizes will be specified by Rockwell International prior to well construction.

General procedures for the installation of monitoring wells are described in Appendix A. At some wells, geophysical logging may be performed prior to well completion.

STORAGE AND DISPOSAL OF DRILLING AND SAMPLING WASTES

Sampling and drilling activities could generate potentially hazardous solid and liquid "wastes". The activities, anticipated type and amount of waste, and planned handling of the wastes are summarized below.

- Soil/waste sampling: solid, auger cuttings and excess soil/cuttings collected but not retained in sample containers--returned to borehole upon completion (Cement plugs to be placed at the base of the borehole and at the surface. Each plug is to be approximately 3 feet thick. Bedrock formations shall be completely sealed off from overlying surficial materials prior to placing cuttings in the borehole.); liquid - none.

- Monitoring well installation: solid, screened and bulked in drums (depending on screening results) for composite testing and appropriate disposal; if not drummed, cuttings left in place adjacent to well; drilling fluid - discharged to ground surface.

Solid wastes such as disposable booties, Tyvek, contaminated paper, and Saran Wrap, will be considered hazardous for disposal purposes. Rockwell International will provide appropriate containers for these wastes. The Contractor is responsible for transporting the containers from the supply depot at Rocky Flats to the drilling site and drumming the wastes. Rockwell International will be responsible for waste disposal. No "sanitary" trash, e.g., pop cans, etc. is to be included in the hazardous waste drums.

HEALTH AND SAFETY

Contractor personnel must be health and safety trained for drilling at hazardous waste sites. Drilling and sampling at waste source areas will be conducted wearing Level B protective clothing and respiratory protection. All other drilling and sampling will be initially conducted in Level C protective clothing and respiratory protection. The contractor will provide all necessary protective clothing and respiratory protection for contractor personnel. All respiratory protection must comply with 29 CFR 134. All Level B activities will be performed using an approved air line respiratory system. The contractor must provide proof of respiratory fit tests for all of their employees working at Rocky Flats. In addition, all the contractors employees must pass a respiratory chamber fit test performed by Rockwell International. Each Contractor member will be required to have current certification in American Red Cross Multi-Media First Aid and Cardiopulmonary Pulmonary Resuscitation (or the equivalent). In addition, training for all field team members will meet right-to-know requirements. Further details regarding personnel protection requirements are provided in Appendix B.

MEASUREMENT AND PAYMENT

Item 1. Mobilization and Demobilization of Equipment

Measurement and payment for this item will be on a lump sum basis. This item shall include full compensation for all labor, material, transportation charges, and other incidentals necessary to mobilize and demobilize drill rigs, pumps, power supply, lights, pipes, hoses and all other related equipment and supplies are required.

Item 2. Drilling

Measurement and payment for this item will be on a per foot basis for drilling with continuous drive samples. This item shall include full compensation for labor, materials, equipment charges and other incidentals necessary to satisfactorily drill the wells as specified in Appendix A.

Item 3. Completion

Measurement and payment for this item will be on a per installed foot basis. This item shall include full compensation for labor, materials, equipment charges and other incidentals necessary to satisfactorily complete the wells as specified in Appendix A. At the Contractor's option, a proposal can be submitted for hourly rates.

Item 4. Well Development

Measurement and payment for this item will be on an hourly basis. This item shall include full compensation for labor, materials, equipment charges and other incidentals necessary to develop the wells as specified in Appendix A.

Item 5. Standby with Crew

Measurement and payment for this item will be on an hourly basis for time authorized by Rockwell International in the field when required.

Item 6. Standby with Crew

Measurement and payment for this item will be on an hourly basis for time authorized by Rockwell International in the field when required.

Item 7. Additional Rig Time

Measurement and payment for this item will be on an hourly basis for additional drilling time authorized by Rockwell International in the field when required.

SEALING OF OLD WELLS

This task involves the plugging/sealing of old monitoring wells. The Contractor will provide a separate cost estimate for sealing the wells. There are 65 wells being considered for sealing. The cost estimate will be on a per well basis using the following dimensions; 3 inch diameters by 30 ft., 3 inch diameter by 260 ft., 4 inch diameter by 20 ft., 6 inch diameter by 150 ft., 6 inch diameter by 30 ft.

Each well will be sealed using a 6.5 gallon of water, 3-5 pounds of bentonite and 94 pounds of cement mixture. The mixture will be pumped through a tremie pipe suspended 2-3 feet off the bottom of the well. As the well fills, the tremie pipe will be gradually raised out of the well until grout is visibly seen flowing out of the well. Rockwell International will supervise all sealing activities.

APPENDIX A

APPENDIX A

1. DRILLING AND SAMPLING

1.1. PURPOSE

To provide procedures for borehole drilling and sampling.

1.2. DEFINITIONS

- Monitor Wells: Two-inch wells designed for monitoring water levels and groundwater quality.
- Alluvial Wells: Monitor wells completed in surficial materials (Rocky Flats Alluvium, colluvium, or valley fill alluvium).
- Bedrock Wells: Monitor wells completed in saturated sandstone of the Arapahoe or Laramie Formations.
- Piezometers: Two-inch wells completed in claystone of the Arapahoe or Laramie Formations for monitoring water levels.
- Surface Casing: Casing set and grouted through surficial materials in bedrock wells to prevent interconnection of shallow and deep flow systems.

1.3. RESPONSIBILITY

The Rockwell International CEARP Manager is responsible for the drilling and sampling program.

The Subcontractor Site Manager is responsible for direct supervision of drilling and sampling. The Subcontractor Site Manager will report daily to the Rockwell International CEARP Manager on drilling and sampling progress including any problems encountered implementing the field program.

The Field Team Leader is responsible for supervision of drilling, verification of drilled depths, and approval of the Driller's daily logs. The Field Team Leader is also responsible for sample collection, handling, and field screening.

The Driller is responsible for operating and maintaining the rig and auxiliary equipment, for keeping a clean and safe working environment, and for assisting the Field Team Leader with sampling.

1.4. EQUIPMENT AND MATERIALS

- Drilling rig with auger, rotary tricone, and diamond coring systems
- Water truck
- Rod trailer
- Maintenance and access vehicles
- Miscellaneous drilling equipment
- Volatile organic-free water
- Electric well sounder
- Glass jars and lids
- Labels
- Core boxes
- Plastic wrap
- Pipe wrenches
- Rock hammer
- Pocket knife
- Hand lens
- Tape measure divided in tenths of a foot
- Dropper bottle of hydrochloric acid
- Protractor
- Marking pens and pencils
- Field notebook
- Log of boring form

1.5. PROCEDURES

1.5.1. Alluvial Wells

(1) Alluvial wells will be drilled with hollow stem augers where practical. Boulders in the Rocky Flats Alluvium may prohibit the use of hollow stem augers, in which case alternative drilling methods such as tricone rotary will be used. Sampling through surficial materials will be performed by continuous sampling through the hollow stem augers (with split tube inner barrel) or by split spoon, depending on the materials.

(2) Alluvial wells will be drilled approximately one to three feet into bedrock. They will be terminated after confirming the presence and lithology of bedrock.

(3) The hole diameter will be a minimum of four inches. The use of hollow stem augers eliminates the need for drilling fluids; however, some volatile organic-free water may be used if hole stability is a problem. In no event will mud or foaming agents be used.

1.5.2. Bedrock Wells

(1) Bedrock wells will be augered and rotary drilled through surficial materials and weathered bedrock as described above.

(2) Upon penetration of unweathered bedrock, steel surface casing will be set and neat cement grout will be placed in the annulus through a tremie pipe or by pushing a plug of cement through the surface casing. The surface casing will be approximately 6 in. in diameter.

(3) Grout will be neat Type I or Type II Portland cement, mixed with volatile organic-free water at a mix ratio of 6 to 9 gal. of water per 94-lb bag of cement. Grout will be allowed to set at least twenty-four hours before drilling resumes.

(4) The hole will proceed through bedrock by rotary coring (size NX or larger), using bentonite mud, volatile organic-free water, air mist (air and volatile organic-free water), or filtered air.

(5) Drilling will progress into bedrock until at least 3 ft of saturated sandstone within a 10-ft interval of bedrock is encountered, or until the well is approximately 100 ft deep. Wells may be drilled deeper than 100 ft to fully penetrate a sandstone.

(6) After drilling through sufficient sandstone thickness (as defined above), the hole will be cleaned and stabilized for packer testing.

(7) Geophysical logging may be performed in some holes after packer testing.

(8) After packer testing and geophysical logging are completed, the hole will be reamed, if necessary, to a minimum of 4 in. for well installation.

1.5.3. Sampling and Logging

(1) The Driller will provide either continuous samples from a split tube sampler, split-spoon samples, rotary cuttings, or NX core, depending on the drilling method.

(2) As drilling progresses, the Field Team Leader will confirm sample depths with the Driller, describe the samples, and field screen the sample for organic or radioactive contamination. Descriptions and screening results will be recorded in the field notebook and on a log of boring form. The Field Team Leader will also note the depth at which groundwater is encountered.

(3) Sample descriptions will include the following items as appropriate:

- Borehole designation
- Time and date
- Interval footage and recovered footage
- Name of unit and/or brief rock name
- Characteristic structures of the unit
- Fossils
- Lithologic description
- Nature of contacts
- Water content
- Organic and radioactive field screening results.

(4) Auger and rotary cuttings will be bottled in glass jars and labeled. Intervals designated for chemical analyses will be placed in jars and stored on ice in coolers. These samples will be delivered to the onsite laboratory, if an onsite laboratory is used, within 3 hours of collection.

(5) Core continuous split tube samples, and split-spoon samples will be wrapped with clear plastic to prevent rapid drying and cracking and placed in NX or NC size core boxes as appropriate. Wooden blocks will be inserted in the boxes at the beginning and end of runs to mark footages and will indicate lost core zones. Core boxes will be labeled and stored.

(6) The Driller will keep a daily log detailing footage drilled, material used, and stand-by time. The Field Team Leader will keep an independent record of drilling activities in the field notebook to verify the daily logs. One copy of the daily logs will be submitted to the Subcontractor Site

Manager and Rockwell International CEARP Manager by the Field Team Leader on a weekly basis.

1.6. RECORDS

- Log of boring
- Driller's daily logs
- Field notebook

5. DECONTAMINATION OF DRILLING, TESTING, AND SAMPLING EQUIPMENT

5.1. PURPOSE

To provide procedures for equipment decontamination.

5.2. DEFINITIONS

Equipment: Augers, drill pipe, bits, sampling devices, tools, tremie pipe, packers, water pipe, geophysical logging equipment, casing, electric well sounders, pumps, and all other miscellaneous equipment used in drilling, sampling, testing, logging, installing, and developing monitor wells.

Decontamination: Decontamination is the process of cleaning equipment to avoid transport of contamination.

5.3. RESPONSIBILITY

The Field Team Leader is responsible for supervising and approving the decontamination cleaning of equipment.

The Driller is responsible for cleaning all drilling, sampling and well construction equipment and assisting the geophysicist in cleaning geophysical probes and cables.

5.4. EQUIPMENT AND MATERIALS

- Portable Steam Cleaner
- Brushes and Buckets
- Organic-free Water
- Alkaline Detergent

5.5. PROCEDURES

5.5.1. Drilling and Well Installation Equipment

(1) Decontaminate all drilling equipment before starting the first borehole.

(2) Upon termination of a borehole, decontaminate all drilling, packer testing, and geophysical logging equipment as well as stainless steel well casing and screen.

(3) Decontamination will include:

(a) a rinse with the steam cleaner using organic-free water;

(b) scrubbing with brushes using a solution of organic-free water and an alkaline detergent; and

(c) a final rinse with the steam cleaner using organic-free water.

(4) Cover drilling equipment with a clean sheet of plastic after it is decontaminated. Install wet casing and screen in the borehole.

(5) Decontaminate all equipment and tools used in well installation.

(6) Before moving to the next drill site, decontaminate the wireline cable by pulling it off the drum to the appropriate length. Also decontaminate the rig table and mast.

5.5.2. Sampling Equipment

(1) Decontaminate all sampling equipment before collecting the first sample and after each sample collected.

(2) Decontamination will include:

(a) scrubbing with brushes using a solution of organic-free water and an alkaline detergent; and

(b) a rinse with organic-free water (a steam cleaner may be used).

(3) Decontaminate the electric well sounder probe and cable before and after measuring water levels.

(4) Decontaminate pumps and pump line exteriors before and after pumping a monitor well. Decontaminate the internal system of pumps and tubing by pumping at least 1 tubing volume of organic free water through the pump.

(5) Discard bailer rope after each use. Attach new polypropylene rope to the bailer at each well.

5.6. RECORDS

- Field Notebook

6. PACKER TESTING

6.1 PURPOSE

To provide information for executing and analyzing packer tests.

6.2. DEFINITIONS

Packer Tests: Packer tests are performed in cored sections of open boreholes to isolate and test the hydraulic conductivity of selected zones. The selected zone is sealed with packers and water is injected into the formation under constant pressure. The flow rate and water pressure in the test section is then compared to the hydraulic conductivity of the material (DOI 1980).

Packer: A packer is a pneumatically inflatable rubber gland which is used to seal a section of the borehole against leakage so that water pressure can be applied to the test section. Single or paired "straddle" packers will be used to isolate test zones (U.S. DOI 1980).

6.3. RESPONSIBILITY

The Subcontractor Site Manager is responsible for determining the borehole intervals to be tested. The test intervals will be approved by the Rockwell International CEARP Manager prior to the packer tests.

The Field Team Leader is responsible for supervising packer tests, recording all data, and analyzing data.

The Driller is responsible for performing packer tests.

6.4. EQUIPMENT AND MATERIALS

- Organic-free water supply
- Packer assembly
- Pressure gauge assembly
- Flow metering device
- Nitrogen supply and associated connections
- Watch
- Lithologic log of borehole being tested

- Tape measure divided in tenths of feet
- Packer test data sheets
- Field notebook

6.5. PROCEDURES (DOI 1980)

6.5.1. Test Procedures

(1) Record background information at the top of the packer test data sheet.

(2) Remove the core barrel and other tools from the hole.

(3) Set the packers at the prescribed depth and inflate to at least 70 psi above hydrostatic pressure.

(4) Fill the test section with water and adjust the water pressure so the combined static plus gauge pressure does not exceed approximately one-third of the overburden pressure at the top of the test section. Use an overburden pressure of 1 psi/ft.

(5) Observe any leaks in the packer assembly or the packer seal and reseat the assembly as necessary.

(6) Record the flow rate of water into the hole in gallons per minute at equal intervals until steady readings are achieved (at least 15 minutes).

(7) Repeat the test twice more in the same test interval, first at a combined pressure head of approximately two-thirds the overburden pressure, and then again at a combined pressure head of approximately one-third the overburden pressure. The same data recording and time intervals described above should be used.

6.5.2. Data Analyses Procedures

Data analyses will be performed by the Field Team Leader as the tests are performed to assure reasonable results. Calculations will be verified in the office.

The formula for calculating hydraulic conductivity from packer test data is

$$K = \frac{Q}{2(PI)(L)(H)} \ln\left(\frac{L}{r}\right),$$

where

K = Hydraulic conductivity (ft/min),
Q = Injection rate ($feet^3$/min),
L = Length of test section (ft),
H = Differential head of water (ft),
= Distance from the water table to the gage plus gage pressure for test intervals below the water table,
= distance from the center of the test interval to the gage plus gage pressure for test intervals above the water table,
r = Radius of borehole (ft),
ln = Natural logarithm, and
PI = 3.141592.

6.6. RECORDS

- Packer test data sheet
- Field notebook

6.7. REFERENCES

Department of the Interior, Bureau of Reclamation, 1974, *Earth Manual - A Water Resources Technical Publication*, US Government Printing Office, 810 p.

8. WELL INSTALLATION

8.1. PURPOSE

To provide procedures for monitor well construction and installation.

8.2. DEFINITIONS

Monitor Well: Two-inch well designed for monitoring water levels and groundwater quality.

Alluvial Well: Monitor well completed in surficial materials (Rocky Flats Alluvium, colluvium, or valley fill alluvium).

Bedrock Well: Monitor well completed in saturated sandstone of the Arapahoe or Laramie Formations.

Piezometers: Two-inch well completed in claystone of the Arapahoe or Laramie Formations for monitoring water levels.

8.3. RESPONSIBILITIES

The Subcontractor Site Manager is responsible for selecting completion intervals and well designs. Completion intervals and well designs will be approved by the Rockwell International CEARP Manager prior to well construction.

The Field Team Leader is responsible for supervision and documentation of well completions.

The Driller will assemble and install all materials.

8.4. EQUIPMENT AND MATERIALS

- Schedule 5 Type 316 stainless steel casing
- Schedule 5 Type 316 stainless steel wire wrap screen
- Type 316 stainless steel centralizers
- Bentonite pellets
- Appropriate filter pack
- Neat Type I or II Portland cement

- Concrete mix
- Organic-free water
- Five-gallon buckets
- Tremie pipe
- Hoses and pump
- Shovel
- Trowel
- Protective surface casing
- Padlock
- 100-ft tape measure divided in tenths of a foot with a weight on the end
- Electric well sounder
- Well construction summary data sheets
- Field notebook

8.5. PROCEDURES

(1) Pull all augers and drill pipe from borehole. If borehole stability is a problem, the wells may be completed inside the hollow stem augers.

(2) Decontaminate drilling equipment and casing.

(3) Measure depth to water and design well construction.

Alluvial Wells. The screened interval in alluvial wells will extend from approximately 1 ft below the top of bedrock to 2 to 5 ft above the water table. A filter pack designed for the grain size of the formation will be placed around the screened interval and will not extend more than 2 ft above the top of the screened interval. A 1-ft-thick bentonite seal will be placed above the filter pack, and the annulus will be tremie grouted with neat Portland Type I or II cement to the surface. Cement may be poured from the surface if the cemented interval is within 5 ft of the surface. A locking steel protective casing will be placed over the well, and a concrete surface pad, approximately 3 ft in diameter, will be poured around the surface casing. The pad will be sloped so as to drain away from the well.

Bedrock Wells. Bedrock monitor wells will be screened across the entire interval of saturated sandstone with a minimum screened interval of 5 ft. Filter pack, bentonite, cement grout, protective casing, and a concrete pad will be placed as described above.

Piezometers. Deep boreholes which do not encounter sufficient sandstone thickness after drilling through 70 ft of claystone with an average hydraulic conductivity of 5×10^{-7} centimeters per second will be completed as piezometers with two-inch, Schedule 80, threaded and flush jointed, polyvinylchloride (PVC) casing. Ten ft of machine slotted casing will be placed at the base of the casing string. The remainder of the well completion will be as discussed above for alluvial monitor wells.

(4) Calculate the amount of filter pack, bentonite, and cement that will be required for well construction.

(5) Weld end cap on the bottom of the well screen with a stainless steel welding rod, and thread the casing string together.

(6) Place centralizer in the center of the screened interval, and determine its location on the casing string to the nearest 1/100th foot.

(7) Measure the length of the screened interval and the blank casing to the nearest 1/100th ft.

(8) Measure total depth of the open borehole. If the bottom of the borehole is below the base of the screen, backfill it with bentonite pellets or tremie cement grout to the base of the screen. If the open borehole is backfilled with grout, allow it to set for 24 hours before well completion. Measure total depth of the open borehole again.

(9) Place casing string in open borehole. Place slip-on cap on top of the casing string. Measure stick up to determine total well depth. Check well design for correct total depth.

(10) Slowly pour filter pack into borehole annulus, making sure it is evenly distributed around the well casing. Gently shake the casing as filter pack is added to avoid bridging of the filter pack. Measure depth to the top of the filter pack after each bag is added. Make more frequent measurements as filter pack approaches the top of the screened interval.

(11) Record the final depth to the top of the filter pack on well construction summary sheet. Record amount of filter pack used in the field notebook.

(12) Pour bentonite pellets into borehole annulus, making sure they are evenly distributed around the well casing.

(13) Measure depth to the top of the bentonite seal and record on well construction summary sheet. Record amount of bentonite used in the field notebook.

(14) If the bentonite pellets are above the water table, add 1 to 2 gal. of organic-free water to the hole. Allow the bentonite to swell for approximately 15 minutes before grouting to the surface.

(15) Mix neat Type I or II Portland cement (as directed by the Subcontractor Site Manager) at a mix ratio of 6 to 9 gal. of water per 94-lb bag of cement.

(16) Place tremie pipe in borehole annulus and attach appropriate hoses and pump.

(17) Pump grout down borehole annulus. Pour grout from the surface if the cemented interval is within 5 ft of the surface. Record amount of cement used in field notebook.

(18) Measure final stick-up of well casing and record on well construction summary sheet.

(19) Set protective surface casing over stainless steel well casing.

(20) Allow grout to set for 24 hr.

(21) Place form for concrete surface pad around well casing.

(22) Mix concrete and pour surface pad around well casing. Slope pad away from the well with a trowel.

(23) Weld well number on protective surface casing.

8.6. RECORDS

- Well Construction Summary
- Field notebook

9. WELL DEVELOPMENT

9.1. PURPOSE

To provide procedures for well development.

9.2. DEFINITIONS

Well Development: Well development is the process by which fines from the formation and/or filter pack are removed from the vicinity of the well bore in order to increase the efficiency of the well (UOP Johnson Division 1975).

9.3. RESPONSIBILITY

The Subcontractor Site Manager is responsible for determining which method of development will be used. Well development methods will be approved by the Rockwell International CEARP Manager prior to well development.

The Field Team Leader is responsible for well development.

The Driller will be responsible for supplying an air compressor with an air filter if the well is developed by the air lift method.

9.4. EQUIPMENT AND MATERIALS

- Electric well sounder
- Tape measure calibrated in tenths of feet
- Stainless steel pump*
- Air compressor*
- Teflon bailer*
- Bailer rope*
- PVC drop pipe*
- Gasoline powered generator*
- One liter beaker
- Watch
- Calculator
- Well development summary sheets
- Field notebook

*NOTE: The use of these materials will depend on the method of well development selected.

9.5. PROCEDURES

The well will be developed by pumping, bailing, or air-lifting. Pumping is the preferred method of well development and will be used wherever possible. Air-lifting is less desirable because the potential exists for oils from the air compressor to enter the wells, but may be necessary to adequately stress the wells. An air filter will be used if air-lifting is necessary. Bailing is not an efficient method of well development because of the low flow rates induced by bailing. Bailing will only be done in the event of pump failure and to remove sediments in the bottom of the casing.

(1) Decontaminate all equipment prior to well development.

(2) Measure the water level in the well.

(3) Record the water level on the water level data sheet. Record the date, time, well, and development methods on the well development summary sheet.

9.5.1. Pumping

Well development by pumping will be accomplished by means of a two-inch stainless steel piston pump. The pump will be lowered to approximately 1 ft above the bottom of the well. The well will then be pumped until ten casing volumes of water have been removed from the well, until the well water is clear, or until 4 h have elapsed. The pump will be raised 2 ft at periodic intervals until the entire screened interval is developed.

9.5.2. Air Lifting

Well development by air lifting will be accomplished by using an air compressor and 1-in. PVC air line. An air filter will be attached to the air line from the air compressor to prevent the introduction of compressor oils or other foreign materials into the well.

The 1-in. PVC air line will be lowered until within approximately 2 ft of the bottom of the well. The air line from the air compressor will then be attached to the top section of PVC pipe. The well will then be developed by the introduction of

compressed air into the well for approximately fifteen minutes, or until a column of water is removed from the well. The well will then be allowed to recover and another column of water discharged to the surface. This process will be repeated until 10 casing volumes of water have been removed from the well, until the produced water is clear, or until 4 h have elapsed. At periodic intervals, the air line will be raised 2 ft until the entire screened interval is developed.

9.5.3. Bailing

Well development by bailing will be accomplished using a Teflon bailer and small diameter polypropylene bailing rope. Water, formation and/or filter pack materials will be removed from the well by bailing until 10 casing volumes of water have been removed from the well, until the well water is clear, or until 4 h have elapsed. The bailing rope will be discarded following well development.

9.6. RECORDS

- Well development summary sheets
- Field notebook

9.7. REFERENCES

Johnson, E. E., Inc., *Groundwater and Wells - A Reference Book for the Water-Well Industry*, 1980, Johnson Division, UOP, Inc., Saint Paul, Minnesota, 440 p.

APPENDIX B

4.2. PERSONNEL PROTECTION REQUIREMENTS

As stated in the CGMP and IGMP/CSPCP Health and Safety Plan, the Environmental Protection Agency (EPA) has established four levels of protection for personnel entering potentially hazardous zones. All personnel entering such a zone will be required to wear the attire designated for that zone.

4.2.1. Justification for Proposed Levels of Protection

Four levels of protection are associated with anticipated concentrations of volatile organic compounds as shown below (EPA 1984):

0 - background	--	Level D
bkg - 5 ppm	--	Level C
5 - 50 ppm	--	Level B
> 50 ppm	--	Exit site and inform the Subcontractor Site Health and Safety Coordinator and the Rockwell International CEARP Manager.

Volatile organics will be monitored using a photoionization detector in the breathing zone. The breathing zone is that area of the work site at nose/mouth height.

Levels of protection are also associated with anticipated levels of radiation hazards. At a minimum, Level C protection will be required for all personnel performing a specific activity at a particular site that may expose them to radiation. In addition to this preventive measure, external exposure will be monitored using a Geiger-Mueller detector according to EPA guidance (EPA 1984). If radiation levels are below 1 mRem/hr, work will continue uninterrupted. If levels are in the range of 1-10 mRem/hr, work will stop and the Subcontractor Site Health and Safety Coordinator will evaluate the situation. At levels greater than 10 mRem/hr, personnel will leave the site immediately and notify the Subcontractor Site Health and Safety Coordinator and the Rockwell International CEARP Manager.

4.2.2. Proposed Levels of Protection for Specific Activities

The levels of protection for specific work activities at the sites are discussed below. These levels were established preliminarily by evaluating available site data,

identifying anticipated levels of potential hazards, and assigning a level of protection based on the guidance outlined above. These levels of protection may be modified by the Subcontractor Site Health and Safety Coordinator according to specific field conditions, and documented according to procedures given in Section 3.5.

4.2.2.1. Activity 1 - Geophysical Surveys

For all non-intrusive geophysical surveys Level D protective gear will be used.

4.2.2.2. Activity 2 - Drilling and Well Installation

Groundwater monitoring wells will be installed near the high-priority sites. Data from groundwater samples indicate that low levels of alpha radioactivity and volatile organics may be encountered when installing wells. Therefore, Level C protective gear will be initially used for all drilling and well installation activities.

4.2.2.3. Activity 3 - Development, Sampling, and Testing of Monitor Wells

Monitor wells will be developed, sampled, and tested near the high-priority sites. For reasons stated in Activity 2, Level C protective gear will initially be used for all well development, sampling, and testing activities. A photoionization detector will be used to monitor the head space of the well for organic compounds.

4.2.2.4. Activity 4 - Surface Water

Surface water will be collected from Walnut and Woman Creeks. Level D protective gear will be used for this activity.

4.2.2.5. Activity 5 - Surface Soil and Sediment

Sediment samples from Walnut and Woman Creeks will be sampled. Level D protection will be used for this activity. Surficial soil samples will be taken at the high-priority sites. Level C protection will be required at the 903 Pad Area Site and the Mound Area Site. Level D protection will be used at the other locations.

4.2.2.6. Activity 6 - Waste Source Sampling - Invasive Procedures

Level B protective gear is required for invasive sampling since the contents and concentrations of the wastes are unknown.

4.2.3. Protective Equipment

A variety of safety equipment will be used to protect personnel from safety hazards and minimize exposures to hazardous chemicals and radionuclides during site characterization (remedial investigation) activities. A generic listing of available safety equipment is presented in the CGMP and IGMP/CSPCP Health and Safety Plans. An organic vapor analyzer, photoionization detector, and alpha/beta/gamma detectors will be required for initial entry onto all sites. In addition, Class D fire extinguishing material is required for entry to the East Trenches Site. Additional protective equipment, although not required, will be available as needed. Required protective equipment may be deemed optional if current monitoring data indicate that hazards of concern are not present.

4.2.4. General Safety Practices and Mitigation Measures

As stated in the IGMP/CSPCP Health and Safety Plan, some hazards can be minimized through implementation of specific procedures, use of special equipment, training of personnel, or availability of emergency response equipment in the event of an accident. The general requirements listed in the CGMP and IGMP/CSPCP Health and Safety Plans will be observed during all field investigations. Morning meetings for all personnel involved in sampling will be held daily. These meetings will be used to express health and safety concerns related to the days activities.

4.3. SITE ACCESS CONTROL

4.3.1. Restricted Access Zones

As stated in the CGMP and IGMP/CSPCP Health and Safety Plans, control zones will be established prior to the commencement of work at contaminated sites. The exclusion zone will include an approximately 20- ft radius around the work site. The actual dimensions of this zone will take into consideration the space required for

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safe operation of equipment, topography of the site, extent of contamination, and potential for airborne transport.

4.3.2. Decontamination

Decontamination is required for personnel, equipment, and vehicles to prevent the spread of contamination to adjacent areas, reduce the possibility of cross-contamination of wells and samples, and protect employees. The decontamination of equipment and personnel will be conducted in steps from the exclusion zone through one or more contamination reduction zones to a final clean zone. The following decontamination procedures will be initiated after each sample or prior to leaving the contamination reduction zone. Decontamination procedures are listed by personnel protection levels.

Level D

Minimum personnel decontamination - Dispose of Level D protective clothing.

Minimum equipment decontamination -

Step 1 - Wash equipment with an alkaline detergent.

Step 2 - Rinse with tap or distilled water.

Level C and B

Minimum personnel decontamination: Level C and B decontamination will follow procedures as outlined by the Environmental Protection Agency (EPA 1985c).

Minimum equipment decontamination:

Step 1 - Brush excess soil and wash with an alkaline detergent.

Step 2 - Rinse with tap water (from a steam cleaner).

Step 3 - Survey with both the photoionization detector probe to determine if any residual contamination exists. If so, repeat steps 1, 2, and 3 until no contamination is detected. Proceed to the next sampling location.

Where radioactive contamination of vehicles or equipment is suspected, an area of 100 sq cm will be smeared and counted with an alpha scintillation detector. A Geiger-Mueller detector will also be used when there is a potential for uranium contamination. The following guidelines will be used to decontaminate radioactively contaminated equipment for general use (NRC 1979).

Alpha Emitters

Removable (smears):	<20 dpm/100 cm^2
Nonremovable (fixed):	<250 dpm/100 cm^2

Beta and Gamma Emitters

Removable (smears):	<1000 dpm/100 cm^2
Nonremovable (fixed):	<5000 dpm/100 cm^2, average
	<15 000 dpm/100 cm^2, maximum

If these limits are exceeded, further decontamination will be necessary. If further measures fail to adequately decontaminate the equipment, it will be disposed of according to plant policy.

4.4. WORKER TRAINING

As described in the CGMP and IGMP/CSPCP Health and Safety Plans, health and safety training will be conducted and documented for all team members. The level of training for each team member will be commensurate with job functions and potential hazards in work areas and comply with the RCRA Part B Operating Permit Application, Section H. Two members of each field team will be required to have current certification in American Red Cross Multi-Media First Aid and Cardiopulmonary Pulmonary Resuscitation (or the equivalent). In addition, training for all field team members will meet right-to-know requirements.

4.5. EMPLOYEE MEDICAL PROGRAM

As stated in the CGMP and IGMP/CSPCP Health and Safety Plans, site characterization (remedial investigation) field team members shall participate in an employee medical examination program. Their suitability for conducting field sampling

activities (including possible respirator use) will be evaluated and documented by a physician. Medical programs must comply with requirements of DOE Order 5480.1A Chapter VIII.

4.6. RECORDS AND REPORTING REQUIREMENTS

As stated in the CGMP and IGMP/CSPCP Health and Safety Plans, subcontractors will maintain health and safety records and submit reports, as required by DOE Orders. These reports will be distributed as defined in the IGMP/CSPCP Health and Safety Plan.

4.6.1. Exposure and Medical Records

As stated in the CGMP and IGMP/CSPCP Health and Safety Plans, subcontractors will maintain confidential medical records for each field team member. These records will identify individuals by name, date of birth, social security number, and additional identifiers as desired by the subcontractor. The employee's accident record, history of exposures, and/or possible exposures to hazardous physical, chemical, or biological agents will be included with the medical records.

4.6.2. Accident/Incident Report

As stated in the CGMP and IGMP/CSPCP Health and Safety Plans, the Subcontractor Site Health and Safety Coordinator will notify the Subcontractor Project Manager of any accidents or incidents that occur during site characterizations (remedial investigations). The Subcontractor Site Health and Safety Coordinator will also submit a completed DOE Form F 5484.X, as appropriate.

4.7. EMPLOYEE INFORMATION

As stated in the CGMP and IGMP/CSPCP Health and Safety Plans, the Subcontractor Site Health and Safety Coordinator shall ensure that the following DOE forms are posted where field team members can easily read them:

- Form F 5480.2 Occupational Safety and Health Protection

- Form F 5480.4 Occupational Safety and Health Complaint Form

Also, the Rocky Flats Plant Health and Safety Standard concerning employee right-to-know shall be appropriately posted.